

AP II Pump

SERVICE MANUAL

AP II PUMP SERVICE MANUAL REGISTRATION FORM

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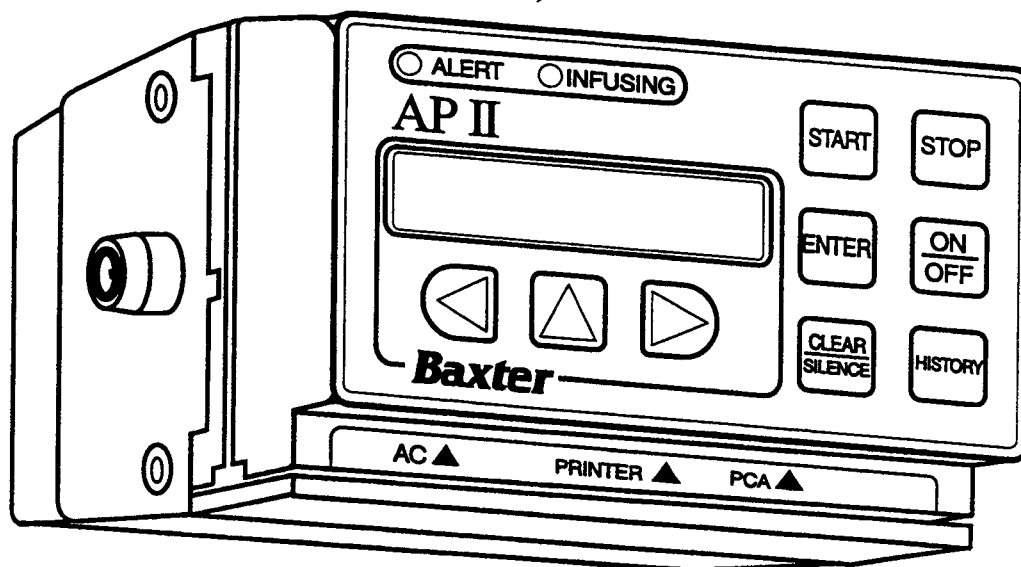
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AP II Pump Service Manual



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ATTENTION

A revision date for these instructions is included (at the bottom of this page) for the user's information. Refer to Appendix E for manual revision history. In the event that two years have elapsed between the most current revision date and product use, the user should contact Baxter Healthcare Corporation to see if additional product information is available.

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1.1 GENERAL

This Service Manual has been developed to introduce the Biomedical Technician to the AP II Pump. This manual will provide a basic understanding of the internal workings of the Pump, functional test procedures, complete assembly/disassembly instructions, troubleshooting, and replacement parts list.

NOTE

Except for the procedures and replacement parts included in this document, no other disassembly or repair should be attempted.

Baxter Healthcare provides a one-year limited warranty for each AP II Pump. If a Pump requires warranty service, call Baxter Healthcare for repair. Unauthorized repairing of a Pump before the warranty has elapsed voids the warranty.

1.2 FACTORY SERVICE/ASSISTANCE

If factory service is desired, Pumps may be returned to Baxter Healthcare for repair.

To expedite repairs, call for a return authorization number before shipping any Pump to Baxter Healthcare.

1.2.1 *Technical Assistance, Service, and Repairs:*

For technical assistance, parts ordering, and service return authorization, contact the Baxter Healthcare Service Center:

1.2.2 *Customer Service Related Business:*

1-800-343-0366

Includes: Part orders and return/repair authorizations.

1.2.3 *Technical Assistance Hotline:*

1-800-634-4602

Includes: Parts identification, troubleshooting assistance and technical training schedules.

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2.1 OVERVIEW OF THE AP II PUMP

The AP II Pump is a small, lightweight, linear peristaltic Pump that may be operated from battery or AC power. A uniquely designed, optional pole-mounting clamp allows the Pump to be unlocked and easily removed for placement into a comfortable carrying case.

The user can program the AP II Pump with prescribed values for the therapy desired. A combination of security code and keying in prescription parameters from the keyboard is required to enter a prescription. Once programmed the Pump remains in the programmed state until the operator turns the Pump off or re-enters the programming screens and changes the prescription. The Pump retains a record of the previous prescription and therapy history while the Pump is in operation or turned off. The user can choose to review the history by pressing the "HISTORY" key or clear history by pressing the "CLEAR" key.

A key is required to unlock and open the Pump fluid bag cover as well as enter or change a prescription. A security code must be entered to access the configuration screens and/or program the Pump. This security code prevents unauthorized prescription changes.

The Pump can also be configured for specific modes, units, and/or prescription limits. This is accomplished through the access of the default configuration screens during initial start-up of the Pump. To access the configuration mode refer to the AP II Pump Configuration Manual and the Operator's Manual. Once the Pump has been configured, it will remain in that configuration until purposely changed.

The remainder of this chapter describes the internal working of the AP II Pump. This information is intended to provide a basic explanation of the Pump's operation. Refer to the troubleshooting section for information on Pump maintenance.

2.2 AP II PUMP COMPONENTS

The AP II Pump is divided into modules and subsystems as illustrated by figure 2-1. Figure 2-1 is a functional block diagram of the system and not intended to illustrate component location. The modules and subsystems listed below are discussed later in this chapter.

- Microprocessor and PROM Subsystem
- Bus Subsystem
- Keypad Subsystem
- Supervisory Subsystem
- Power Subsystem
- LCD Subsystem
- Buzzer Circuit
- Motor Subsystem
- Miscellaneous Circuits

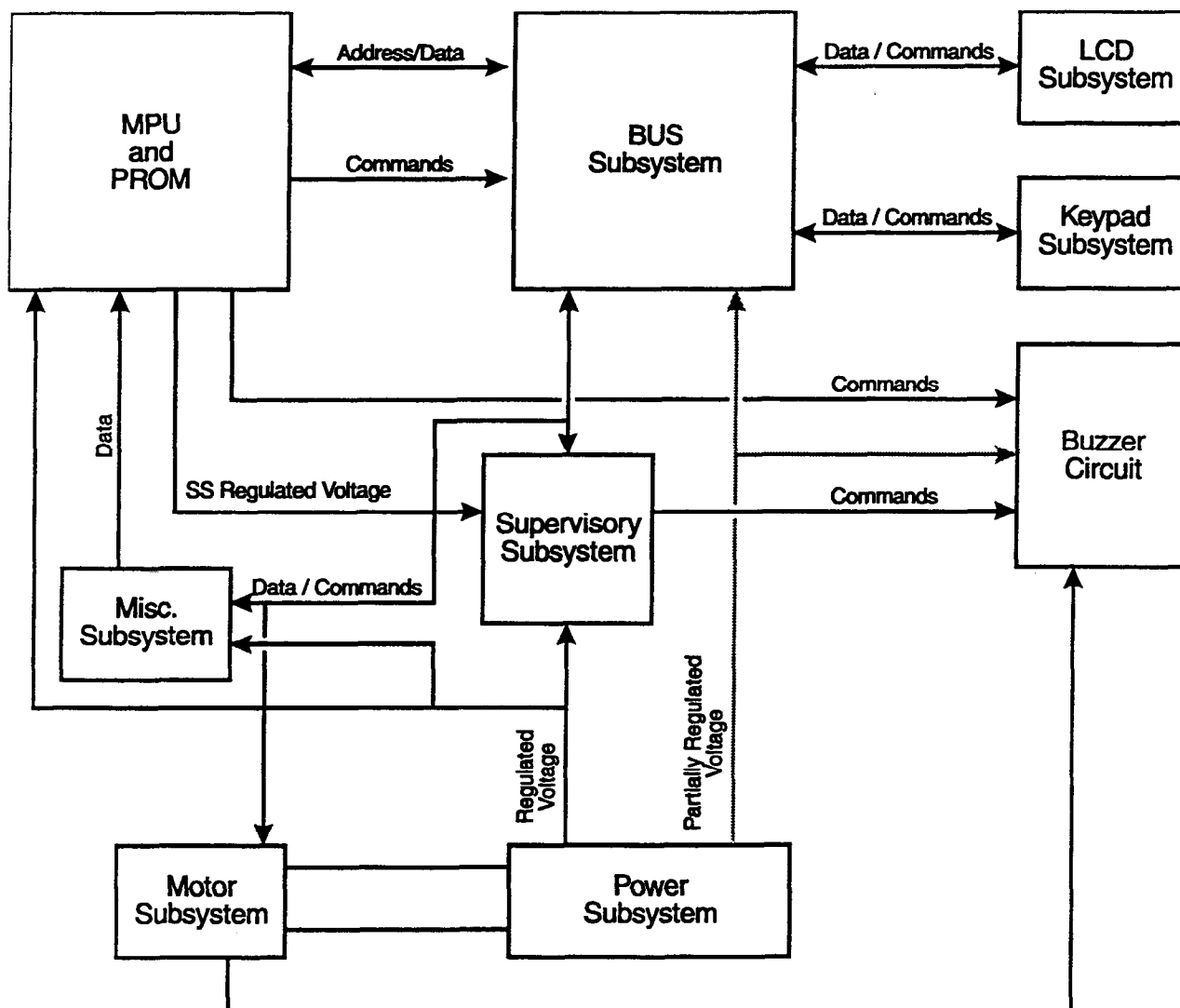


Figure 2-1 AP II Functional Block Diagram

2.2.1 Microprocessor and PROM Subsystem

The AP II Pump is controlled by a microprocessor executing from an external PROM. The microprocessor is a 16-bit single-chip device with two modes of operation. It will operate in the single chip mode whenever possible or in memory expansion mode when accessing devices on the external bus. Running in the single chip mode saves power which is a major factor for this Pump. The processor has eight input/output (I/O) ports which are used to control or monitor the following functions:

- PROM
- LCD Command and Data Register
- Motor Drive
- Watchdog
- Keypad
- Switches
- Buzzer Circuit
- Real Time Clock Circuit
- Occlusion Circuit
- Various voltages

If an error is detected, the processor will initiate an error code which will produce an alert message and audible alarm. A number of power-up tests are performed to ensure that the Pump is running properly. The power-up tests include testing of the LEDs, beeper, backup battery, and input voltages.

Included in the processor subsystem is the real time clock (RTC) circuit. The RTC provides time of day information to the microprocessor. The RTC circuitry keeps track of time when the Pump is off, through the use of a backup battery mounted to the microprocessor circuit board. The backup battery is also used to preserve the contents of the microprocessor RAM when operation power drops below a minimum voltage. The RTC also contains a small amount of RAM which is used by the system software to determine whether there has been a loss of backup battery power.

The PROM subsystem supplies data to the bus when addressed by the microprocessor to identify the operation requested.

2.2.2 BUS Subsystem

The BUS has the capacity to provide for a 24 bit address and 8 bit data path. The microprocessor uses the BUS subsystem to transfer data or instructions to six different functions. These six functions are:

- PROM
- LCD Command and Data Register
- Motor Drive
- Watchdog
- Keypad
- Switches

2.2.3 Keypad Subsystem

The keypad subsystem enables the user to enter the prescription data which is unique to each usage, and to start and stop the device. The keypad subsystem is comprised of nine keys on the membrane keypad and three other switches. The microprocessor samples each of the keys and switches to determine their status. Each of the keys and switches are described below:

KEY	Primary Function
START	Starts operation of the unit.
STOP	Stops operation of the unit.
ENTER	Accepts entered configuration codes, configuration parameters, and limits.
ON/OFF	Turns the Pump ON and OFF.
CLEAR/SILENCE	Clears data stored in history and silences the audio alarm.
HISTORY	Access the history screens to allow scrolling through history data.
Left Arrow Key	Move the cursor to the left.
Up Arrow Key	Scrolls a selected digit to the next higher setting.
Right Arrow Key	Moves the cursor to the right.

SWITCH	Primary Function
PCA Jack	Patient Controlled Analgesia (PCA) switch. The PCA switch is a phono jack which is monitored by the microprocessor to determine the status of the PCA button.
Bag Cover Lock	Internal switch that detects when the bag cover is locked or unlocked.
Tubing Sensor	Switch that detects when the Pump tubing cover is open or closed with tubing set properly installed.

2.2.4 Supervisory Subsystem (SS)

The supervisory subsystem performs a major role in the start-up and shutdown of the Pump. Monitoring and responding to error situations reported by hardware and software is also a function of this circuitry. A "well check" is performed by the SS on some of the error detection hardware circuitry.

The SS also provides the power for the microprocessor and the RTC. As long as the regulated +5V remains above the backup battery voltage, the SS will produce a +5V source for the microprocessor and the RTC. If the regulated +5V falls below the backup up battery voltage, the SS connects the backup battery to the microprocessor and the RTC to preserve the contents of the microprocessor RAM and provide power for RTC operation.

2.2.5 Power Subsystem (PS)

The power subsystem provides the required DC power for the AP II Pump from a 9 volt battery or the AC Adapter. The AC Adapter is an external unit, which when plugged into an AC wall outlet will produce 10 volts DC. The AC Adapter is connected to the AP II Pump at its AC Adapter input jack. When power is available from both the battery and AC Adapter, the PS selects the AC Adapter by default to conserve battery life. The PS automatically switches the LCD backlight to an increased intensity when the AC Adapter power is present.

The PS provides regulated, partially regulated, and unregulated power. In the event that both the battery and AC Adapter are not present, the PS, in conjunction with the SS, will switch the microprocessor and RTC power to the backup battery. This maintains the contents of the microprocessor RAM and keeps the RTC operational.

The unregulated voltage is used primarily to power the motor that drives the AP II peristaltic Pump. The partially regulated voltage is used to power the buzzer and the LCD's backlight circuit. The unregulated voltage is also used as a monitored voltage for the overvoltage fault detector. The regulated voltage is supplied to all of the IC chips.

2.2.6 LCD Subsystem

The liquid crystal display (LCD) subsystem serves as a device for the microprocessor to communicate with the user and facilitate the entry of data from the keypad. The LCD displays two rows of 16 characters, with each character defined by a selection of dots from a 5 x 7 array with a cursor underneath the array.

The LCD can be written to by the microprocessor which supplies it with either data or commands. Information in the LCD's memory is read by the microprocessor. For its functional operation, the LCD has two memories; the character generator (CG) RAM and the display data (DD) RAM. The AP II Pump hardware has no need to distinguish between the two RAMs. This is accomplished by the software running in the microprocessor through the commands it issues to the LCD.

2.2.7 Buzzer Circuit

The buzzer circuit provides an audio output to inform the user of the operational status. The buzzer is accessible through an I/O port from the microprocessor, external hardware, and software. Operational status and error conditions reported by the external interface devices activate the buzzer to produce an audible alarm.

2.2.8 Motor Subsystem

The motor subsystem contains two drive paths to activate the Pump. The paths are known as the positive and negative drive. The Pump drive paths are controlled very precisely by the microprocessor with feedback from two independent shaft position encoders. The encoder information enables precise control over the delivery rate.

To drive the motor, the positive signal must be asserted allowing the motor's negative signal to complete the return conduction path through the motor when it is activated. The motor's positive and negative drive paths are enabled by the microprocessor through different ports.

2.3 MISCELLANEOUS CIRCUITS**2.3.1 Occlusion Detection Circuits**

A check is made for the possibility of blockage (occlusion) during delivery downstream of the AP II Pump. The elastic section of the tubing set (in the area where the fingers of the peristaltic Pump operates) will expand slightly if a blockage exists. The expansion causes a switch to trip enabling the Pump to sense an occlusion. However, before an occlusion is detected, the Pump will check for a wet switch condition to reduce the occurrence of a false occlusion signal.

2.3.2 Backlight Circuit

The backlight circuit provides power for the light emitting diodes (LEDs) in the LCD unit to generate the necessary light to read the display. Since these LEDs consume a significant amount of power, the display is only lit when needed while being powered by the 9 volt battery. The LEDs are driven at less than the nominal rated current. This provides a dim illumination of the display to reduce the drain on the battery. When programming the unit on battery power, the backlight will be on. Fifteen seconds after programming is complete, the backlight will turn off. The backlight will turn on again when a key is pressed.

When the Pump is being powered by the AC adapter, the LEDs are on all the time. The LEDs are supplied with nominal full rated current giving a bright backlight. As long as the AC adapter is providing power, the display will remain lit.

2.3.3 Printer Adapter Interface Circuit.

The interface to the printer adapter enables the microprocessor to produce a printout of the history data. The Pump interfaces with the Baxter Printer Adapter, P/N 2L3400, and a printer (typically a Seiko DPU-411). The printer interface is a serial port that operates on TTL levels and provides data at a 600 baud rate.

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3.1 GENERAL

This chapter contains the information necessary to perform an initial inspection and set up of the AP II Pump. A functional test is included in Chapter 4 to determine if operation is satisfactory.

3.2 INITIAL INSPECTION AND DAMAGE CHECK

The AP II Pump has been thoroughly tested and inspected at the factory prior to shipment and has been found to comply to Baxter's electrical and mechanical standards. The APII Pump has also been designed to reliably withstand normal shipment and usage conditions. However, abusive handling during shipment may cause either visible or hidden damage. Follow the instructions in this section before performing operational checks.

If any damage is observed in any of the following inspections, and this damage is related to shipping, notify the carrier's agent immediately. Do not return the damaged equipment to the factory without written authorization.

3.3 INSPECTIONS

1. Carefully inspect the shipping carton before opening it. Note any obvious damage caused by mishandling and record any such damage.
2. The carton should contain the following:
 - One AP II Pump with a 250E Fluid Bag Cover
 - One Patient Control Button
 - One Pump Carrying Case
 - One Operator's Manual
 - One Quick Programming Guide
 - One Configuration Manual
 - Two Keys
 - One AC Adapter
3. Remove the Pump from the carton. Place the Pump on a flat surface and perform these visual inspections:
 - A. Check the entire surface for chips, scratches, dents, or cracks.
 - B. Check the front keypad panel for damage.
 - C. Check the Fluid Bag Cover for cracks and check to see that it locks properly.
 - D. Turn the Pump over and verify that the serial number matches that on the shipping carton. Refer to the Operator's Manual for tracking information.

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4.1 GENERAL

The AP II Pump design includes extensive self-tests which continually monitor the Pump's operation. These checks occur during normal operation of the device. When an alarm or fault condition is detected, the Pump generates an alert message, flashing LED indicators and/or an audible alarm. These indicators warn the user of the detected fault. The Pump will stop operating until the fault condition has been corrected. This procedure provides tests that are to be used to ensure that the Pump operates properly.

It is recommended that anyone performing this functional test become familiar with the device operating procedures contained in the AP II Pump Operator's Manual. If the Pump has been configured in such a manner that this test cannot be followed, refer to the AP II Pump Configuration Manual to re-configure the Pump to the factory defaults.

Pumps that fail are to be repaired per Chapter 6 of this manual or be returned to the Baxter Service Center. Record the failure mode and the Pump's setup prior to and during the failure before returning the Pump. Call a Baxter representative for a service authorization number and the procedure for returning a Pump for repair.

It is recommended that the functional test results be recorded on the provided Test Data Sheet contained at the end of this Chapter. The Test Data Sheets should be kept as a preventive maintenance record for each Pump.

4.1.1 Equipment Required

- AP II Pump with battery installed
- PCA Cable
- AC Adapter
- Tubing set
- (2) 250 mL reservoir bags
- Stopwatch or timer (minutes and seconds)
- Fresh distilled water
- Scale with minimum of two decimal place gram readout (for use with gravimetric test)
- 25 or 50 mL burette (for use with volumetric test)

4.1.2 Optional Equipment

- Seiko DPU-411 Printer or equivalent
- Printer Adapter (2L3400)
- Printer Cable (2L3402)

4.2 VISUAL INSPECTION

The unit shall be inspected for the parameters listed below. Upon completion of the inspection, check off pass or fail on the Data Sheet and record any pertinent comments. If the Pump fails any of these inspections, ensure that the applicable service is performed on the Pump before being put to use.

1. **Pump casing** - Verify that the Pump casing is free of visible damage and free of any indication of fluid ingress.
2. **Bag cover** - Verify that the bag cover is properly positioned and secure to the Pump. Verify that it opens and closes freely and without binding.
3. **Bag cover lock** - Verify that the bag cover locks and that the lock cam turns freely when locking and unlocking the cover.
4. **Tubing cover door** - Verify that the tubing cover door opens freely and that the latching mechanism operates properly when the door is closed.
5. **Battery door** - Verify that the battery door operates freely and closes securely when a battery is in place.
6. **Keypad** - Verify that the entire keypad is secured to the case and is not lifting up at the edges. Ensure that the keypad is free of damage.
7. **Labels** - Verify the presence of the following labels:
 - Rear label (on the rear case)
 - Serial no. label (also on the rear case)
 - Reorder label (on the inside of the bag cover)
 - Battery polarity label (inside the battery compartment)

4.3 FLOW RATE ACCURACY TEST

NOTES

A gravimetric method and a volumetric method have been provided. The performance of either method is acceptable. Record all appropriate information on the Data Sheet.

The following procedure should be used to verify the flow rate accuracy of the AP II Pump. The performance of commercially available automated rate testing equipment has not been evaluated by Baxter for use on the AP II Pump. Use of this equipment is therefore not recommended.

Test Set Up

1. Fill the reservoir bag with a minimum of 100 mL of distilled water using a syringe.
2. Remove all the air from the reservoir bag then cap it.
3. Install the tubing set into the pump.
4. Uncap the reservoir bag and attach it to the tubing set.
5. Install the bag into the Pump's bag cover, close and lock the bag cover.
6. Program the Pump as follows:

Mode	= Continuous
Units	= mL
Bag volume	= 100 mL

7. Prime the pump until all the air is removed from the tubing set and reservoir bag.

NOTE: To perform the test using the gravimetric method, proceed to section 4.3.1. To perform the test using the volumetric method, proceed to section 4.3.2.

4.3.1 Procedure using Gravimetric method

1. Set the scale to read in grams.
2. Attach the distal end of the tubing set to an empty 250 mL bag (output bag).
3. Deliver two additional priming volumes to ensure flow to the output bag.
4. Disconnect output bag, cap it, weight it, and record this as the "start weight" on the Data Sheet. After recording start weight, reconnect output bag to tubing.

5. Complete the Pump program as follows:

Rate = 10.0 mL/H
Bolus = 00.0 mL

6. Press **"START"** and start the stopwatch simultaneously.
7. After approximately 1 hour, simultaneously unlock the bag cover and stop the stopwatch. Shut the Pump off.
8. Disconnect output bag, cap it, and weigh it. Record this weight as the "end weight".
9. Record the stopwatch reading in seconds.
10. Use the following formulas to calculate the rate error:

$$\text{test rate (mL/hr)} = \frac{(\text{end weight}) - (\text{start weight})}{\text{elapsed time}} \times 3600$$

$$\text{rate error (\%)} = \frac{10 - \text{test rate}}{10} \times 100$$

Record the test rate and the rate error on the Data Sheet.

11. If the rate error is equal to or less than 10%, the Pump passes this test. Otherwise, the Pump fails. Record the results on the Data Sheet.

4.3.2 Procedure using Volumetric method

1. Attach the distal end of the tubing set to a 25 or 50 mL burette.
2. Deliver two additional priming volumes to ensure flow to the burette.
3. Record the volume reading on the burette as the "start volume" on the Data Sheet.
4. Complete the Pump program as follows:

Rate = 10.0 mL/H
Bolus = 00.0 mL

5. Press **"START"** and start the stopwatch simultaneously.
6. After approximately 1 hour, simultaneously unlock the bag cover and stop the stopwatch. Shut the Pump off.

7. Record the volume reading on the burette as the "end volume".
8. Record the stopwatch reading in seconds.
9. Use the following formulas to calculate the rate error:

$$\text{test rate (mL/hr)} = \frac{\text{difference between end and start volumes}}{\text{elapsed time}} \times 3600$$

$$\text{rate error (\%)} = \frac{10 - \text{test rate}}{10} \times 100$$

Record the test rate and the rate error.

10. If the rate error is equal to or less than 10%, the Pump passes this test. Otherwise, the Pump fails. Record results on the Data Sheet.

4.4 MISCELLANEOUS CHECKS

This section (4.4) is designed to perform tests on the following Pump features: Tubing sensor, Occlusion switch, PCA cable, AC adapter, history retention and printer feature (optional). This section is also designed to be performed as one continuous operation. Record the results of each test on the Data Sheet.

Test Set Up

1. Remove the tubing set from the Pump.
2. Plug the PCA cable into the Pump.
3. Plug the AC adapter into the Pump.
4. Ensure a 9 volt battery is installed into the Pump.

4.4.1 Tubing Sensor Test

Procedure

1. Program the Pump as follows:

Mode = BASAL + PCA
Units = mL
Bag volume = 100 mL

2. At the **"START TO PRIME, ENTER TO PROCEED"** screen, press **"START"**.
3. The screen should display **"CHECK TUBING PLACEMENT"**, the red LED should be flashing and the audible alarm should be sounding. If so, the Pump passes this test. (The **"CLEAR/SILENCE"** key may be pressed to silence the alarm.) Record the results on the Data Sheet.

4.4.2 Occlusion Switch Test

Procedure

1. Unlock the bag cover.
2. The screen should display **"BAG COVER IS UNLOCKED"**, the red LED should be flashing and the audible alarm should be sounding. (The **"CLEAR/ SILENCE"** key may be pressed to silence the alarm.)
3. Open the bag cover, open the tubing cover and install a tubing set into the pump.

4. Close and lock the bag cover. The security code screen should appear.
5. Program the Pump as follows:

Mode = BASAL + PCA
Units = mL
Bag volume = 100 mL
6. At the **"START TO PRIME, ENTER TO PROCEED"** screen, clamp the distal end of the tubing set within about 3 inches from the Pump. Press **"START"**.
7. Before the end of the .5mL priming cycle, the display should read **"DOWN STREAM OCCLUSION"**, the red LED should be flashing and the audible alarm should be sounding. If so, the Pump passes this test. If not, check that the tubing set is properly clamped and repeat the priming cycle. If the Pump still does not go into the Occlusion alarm mode, repeat the priming cycle for a total of 5 times. If the Pump, still does not go into the Occlusion alarm mode after the fifth priming cycle, the Pump fails this test.
8. Record the results on the Data Sheet.

4.4.3 PCA Cable Test

Procedure

1. At the end of the priming cycle of the previous test, the screen should read **"START TO PRIME, ENTER TO PROCEED"**.
2. Press **"ENTER"** and enter the remainder of the prescription as follows:

PCA dose = 1.0 mL
Delay = 3 minutes
Basal rate = 5.0 mL/H
1 Hr. limit = 20.0 mL
Bolus = 00.0mL
3. Press **"START"**. The display should now read **"BASAL + PCA"** and the green LED should be flashing.
4. Wait a minimum of 3 minutes then press the PCA cable button 4 times. The Pump should beep every time the PCA cable button is pressed.
5. Unplug the PCA cable from the pump. The screen should display **"PCA CONNECTOR NOT INSERTED"**, both LED's should be flashing and the audible alarm should be sounding.

6. Re-insert the PCA cable into the pump. The screen should now display "**BASAL + PCA**", the green LED should be flashing and the alarm should be off.
7. If all the observations in steps 4, 5 and 6 have occurred, the Pump passes this test. Record the results on the Data Sheet.

4.4.4 AC Adapter Test

Procedure

1. Disconnect the AC adapter from the Pump. The backlighting should turn off and after approximately 2 seconds, the Pump will beep 3 times and the icon in the upper right hand corner of the display will change to the battery symbol.
2. Re-connect the AC adapter into the Pump. The backlight will turn on and the screen icon will change to the plug symbol.
3. If all the observations in steps 1 and 2 have occurred, the Pump passes this test. Record the results on the Data Sheet.

4.4.5 History Retention Test

Procedure

1. Turn the Pump off, unplug the AC adapter and remove the 9 volt battery. After approximately 1 minute, re-insert the 9 volt battery and the AC adapter and turn the Pump on.
2. Scroll through the history screens as described in the AP II Pump Operator's Manual. Verify that the prescription is correct and that the INJ/ATT screen indicates 1 INJ 4 ATT.
3. If the history screens are accurate, the Pump passes this test. Record the results on the Data Sheet.

4.4.6 Printer Test (Optional)

Procedure

1. Connect the Printer Adapter to the printer.
2. Insert the Printer Cable to the Printer Adapter and the AP II Pump printer connector.
3. Turn on the printer.
4. Ensure that the active light is illuminated on the Printer Adapter.

5. Press **"PRINT/STOP"** key on the Printer Adapter.
6. Verify that the Pump provides an AP II history printout.
7. If the printout is accurate, the Pump passes this test. Record the results on the Data Sheet.

4.5 FUNCTIONAL TEST DATA SHEET

Record the results of the AP II Pump functional tests on this Data Sheet. This sheet may be reproduced. Pumps that fail any of these tests must be serviced before being put to use.

AP II PUMP S/N: _____ HARDWARE REV: _____ SOFTWARE REV: _____

4.2 VISUAL INSPECTION		
PASS	FAIL	COMMENTS

4.3 FLOW RATE ACCURACY TEST						
4.3.1 Gravimetric Method						
Start Weight	End Weight	Elapsed Time	Test Rate	Rate Error	Results	
					PASS	FAIL

4.3.2 Volumetric Method						
Start Volume	End Volume	Elapsed Time	Test Rate	Rate Error	Results	
					PASS	FAIL

Comments: _____

4.4 MISCELLANEOUS CHECKS			
Feature	Test Results		Comments
	PASS	FAIL	
4.4.1 Tubing Sensor Test			
4.4.2 Occlusion Switch Test			
4.4.3 PCA Cable Test			
4.4.4 AC Adapter Test			
4.4.5 History Retention Test			
4.4.6 Printer Test (Optional)			

Signature: _____

Date: _____

5.1 General

The Pump is designed to provide reliable service with only minor routine maintenance. A periodic functional inspection of the Pump should be made at least every six months to assure proper operation. The Pump should be cleaned and disinfected if necessary, according to frequency of use and hospital protocol.

5.2 Cleaning and Disinfecting

The exterior surfaces of the AP II Pump may be cleaned with a cloth, sparingly dampened with any of the cleaners listed in the table below. Follow manufacturer's dilution instructions for concentrated cleaners. Used Pumps should be cleaned/disinfected with an agent from the list below before use on another patient. Spills and dirt should be cleaned off the Pump as quickly as possible.

Table 5-1 Approved Cleaners and Disinfectants

Cleaner	Manufacturer
Soapy water	N/A
A solution of 10% bleach and water	N/A
LpH	Vestal Labs
Septisol	Vestal Labs
Cidex 7	Surgikos
Super Edisonite	Edison Chemical
TOR or Hi-TOR Plus	Huntington Labs
Bafix	Hysan Corporation

CAUTION

The AP II Pump and AC adapter are not waterproof and should not be immersed. Avoid getting liquids inside the Pump or permanent damage may result. Do not use alcohol for cleaning. Sterilization via ETO, steam, etc. should not be attempted.

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6.1 GENERAL

Pumps under warranty must be returned to the factory for troubleshooting and repair. Unauthorized disassembly/repair will void your warranty. When a Pump is malfunctioning, perform the following to see if Pump operation can be restored. Ensure that the:

- batteries are installed and not depleted.
- batteries are installed correctly (proper polarity).
- patient control switch is properly installed.

If this does not restore the Pump to operation refer to the troubleshooting chart later in this chapter.

WARNING

There are no internal user repairable parts available. The Pump must only be serviced by a trained biomedical engineering technician or Baxter Healthcare personnel.

6.2 TROUBLESHOOTING

The troubleshooting procedure and tables in this section are written for repair to the board level. Except for those items listed, circuit board components are not available from Baxter Healthcare. Refer to Chapter 7 for disassembly procedures and Appendix C for part information.

6.2.1 Board Exchange

A board exchange program is available for the circuit board assembly in the AP II Pump. Baxter Healthcare provides a refurbished board in exchange for a returned defective board. Boards which are damaged through unauthorized rework, missing components, or improper maintenance will not be eligible for this program. Call customer service for an authorization number prior to shipping the defective board.

6.2.2 Mechanism Exchange

Due to the manufacturing process for the mechanism, this assembly cannot be repaired in the field. An exchange program has been established to facilitate cost effective repairs. This program provides a credit for return of a defective mechanism assembly when a refurbished mechanism assembly is ordered. This program is not available when ordering a new mechanism assembly. Call customer service for an authorization number prior to shipping the defective mechanism.

6.2.3 Tools and Equipment

The following list of tools are recommended for use in maintaining and troubleshooting the AP II Pump. The troubleshooting chart assumes that these tools or their equivalent are available for use.

- Oscilloscope
- Wire Cutters
- ESD Protection Station
- Soldering Iron
- Screwdriver (Cross point)
- Permabond 792 Adhesive
- Tubing Set
- Reservoir

6.2.4 Troubleshooting Tips

Table 6-1 Troubleshooting Chart

Symptom	Possible Cause	Solution
No Power (9V)	Dead battery	Check/replace 9 volt battery.
	Broken battery leads	Replace battery contact assembly.
	Defective MPU board	Check for 9 volt line at J10 connector (See Appendix B, #5). If present, replace MPU board. If not, replace battery contact assembly.
No Power (AC)	Poor AC power adapter connection to Pump	Ensure that the red dots are aligned and connector is plugged in fully.
	Defective AC power adapter	Check output of Power Adapter for 10 VDC. Replace AC Adapter.
	Defective power connector in Pump	Check for proper installation of the AC power connector onto the MPU board at J4 (See Appendix B, #6). Replace the Front Case Assembly.
	Defective MPU board	Check for 10 volts at J4 connector. If present, replace MPU board. If not, replace Front Case Assembly.
No Audio Alarm	Defective buzzer	Replace buzzer.
	Defective MPU board	Replace MPU Board.

Symptom	Possible Cause	Solution
No occlusion alarm or constant occlusion alarm	Defective occlusion switch	Check for continuity between pin 8 and 9 of the mechanism while manually activating the occlusion switch. Replace mechanism assembly if defective.
	Defective MPU board	Replace MPU board.
LCD not working or segments missing.	Bent/broken pin on LCD board	Replace gold pin connector.
	Defective LCD board	Replace LCD board.
	Defective MPU board	Replace MPU board.
No backlighting	Poor connection	Check to ensure backlight connector is properly installed.
	Defective LCD board	Replace LCD board.
	Defective MPU board	Replace MPU board.
"Check tubing placement" screen will not clear.	Tubing segment improperly installed or not installed	Assure tubing set is installed properly. Refer to Operator's Manual for proper installation.
	Defective microswitch	With tubing segment properly installed, check for continuity between pin 7 and 8 of mechanism. If circuit remains "open", replace mechanism assembly.
	Defective MPU board	Replace MPU board.
"Bag cover is unlocked" alarm will not clear.	Defective reed switch	Replace rear case half assembly.
	Defective lock assembly	Repair / replace reservoir cover.
	Defective MPU board	Replace MPU board.

Symptom	Possible Cause	Solution
No input from front panel keypad	Defective keypad	With power removed, check keypad for continuity while pressing the suspected key (refer to schematic).
Will not retain memory	Low or dead 3V battery	Replace 3V battery. See 3V battery replacement in section 7.2.5.
	Defective MPU board	Replace MPU board.
Will not accept attempts/injections from PCA switch.	Defective PCA Cable	Replace PCA Cable.
	Defective PCA connector	Replace PCA connector.
	Defective MPU board	Replace MPU board.
Will not print out.	Defective printer connector	Check for bent printer pins. Replace if necessary.

6.2.5 System Error Codes (Failure Codes)

Below is a listing of all error codes that the AP II Pump can generate. Refer to the Troubleshooting Chart (Table 6-1) for corrective action should one of these alarms occur. This list is provided for reference purposes only.

CODE	Description
-------------	--------------------

NOTE

If an error code should appear, remove all power and restart the Pump. A problem is indicated if the alarm persists. Due to the fact that error codes shutdown the unit, it is difficult to troubleshoot without swapping out suspected assemblies. As all error codes are software generated, the MPU board is always suspect.

E01-E09	Not used.
E10	Keypad button held down more than 6 minutes.
E11-E14	Not used.
E15	LCD display is not responding expeditiously.
E16	Red LED is not functioning.
E17	Not used.
E18	Green LED is not functioning.
E19	LCD display returned incorrect RAM pattern.
E20	EEPROM acknowledge not received when expected.
E21	Trying to read/write beyond EEPROM memory.
E22	EEPROM write cycle time-out.
E23	Error while printing history data.
E24	Pump turned on by other than ON key.
E25	CRC failure on internal ROM (8000-FFFF).
E26	CRC failure on external ROM (20000-3FFFF).
E27	External watchdog circuitry failure.
E28-E29	Not used.
E30	No forward motion after several control intervals.
E31	Motor runaway.
E32	Can't reach desired speed.
E33	Main encoder counts 25% over nominal value for one motor rev.
E34	Main encoder counts 25% under nominal value for one motor rev.
E35	Main encoder counts 3% over nominal value for eight motor revs.
E36	Main encoder counts 3% under nominal value for eight motor revs.
E37	Not used.
E38	Motor moving when motor should be stopped.
E39	Motor drive transistor failure.

CODE	Description
E40	Not used.
E41	Excessive motor back counts.
E42	Speed nearing mechanical limits.
E43	Motor not stopping quick enough.
E44-E49	Not used.
E50	RTC vs system clock comparison error.
E51-E54	Not used.
E55	Time read back != time written.
E56	RTC RAM failure.
E57-E59	Not used.
E60	Power supply voltage out of range.
E61-E63	Not used.
E64	No detectable power source.
E65-E69	Not used.
E70	Analog to digital converter time-out.
E71	Illegal interrupt.
E72	Internal watchdog time-out.
E73-E74	Not used.
E75	BUS_COUNT exceeds maximum limit.
E76	Unknown event received by task.
E77	Tried to remove total not in list.
E78	Software Timer Out of Range.
E79	B0_isr held off for more than 60 ms.
E80	Stack overflow.
E81	Variable out of range.
E82	UIT message buffer overflow.
E83	STOP_RX routine called when it should not have.
E84	Delivery attempt made before delay time elapsed.
E85	Attempted to stop injection when no injection in progress.
E86	Volume delivered not within $\pm 0.5\%$.
E87	Attempt to infuse at 0 rate.
E88-E89	Not used.

CODE	Description
E90	UIT state transition error.
E91	History checksum failure, data corrupted.
E92	Error in getting RX data for printing.
E93	Configuration checksum failure, data corrupted.
E94	RX checksum failure, data corrupted.
E95	Unexpected data value.
E96	LCD string length too long.
E97-E99	Not used.

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7.1 GENERAL

This chapter contains a detailed description of the disassembly and assembly procedure for the AP II Pump. Contact Baxter Healthcare if you have any questions while servicing the AP II Pump.

CAUTION

When performing the procedures of this chapter, exercise extreme caution during disassembly to protect the circuit boards from static discharge. The inspection or repair station, all equipment, and personnel should be properly grounded.

NOTE

During disassembly, note the orientation and routing of all cables and connectors. Failure to do so may result in improper operation and/or damage to the Pump upon reassembly.

NOTE

During disassembly, keep track of all hardware and avoid leaving loose hardware in the Pump upon reassembly. Failure to do so may result in improper operation and/or electrical damage to the circuit board.

NOTE

After a component is reassembled it must be aligned or adjusted per the procedure listed as its retest requirement.

NOTE

All Pumps must pass the functional tests in chapter 4 after repair is complete.

7.2 DISASSEMBLY PROCEDURES

The procedure to assemble a component is the reverse of the disassembly unless otherwise noted.

Numbers in parenthesis refer to the numbered parts of the drawing associated with the procedure.

Prior to disassembly, remove all accessories and batteries.

7.2.1 Reservoir Assembly

1. Unlock and open the Reservoir Assembly (1).
2. Remove the 3 pan head screws (3). Save the screws for use during assembly.
3. To remove the Mounting Plate (4), remove the two screws (2) that secure it to the Reservoir (1).

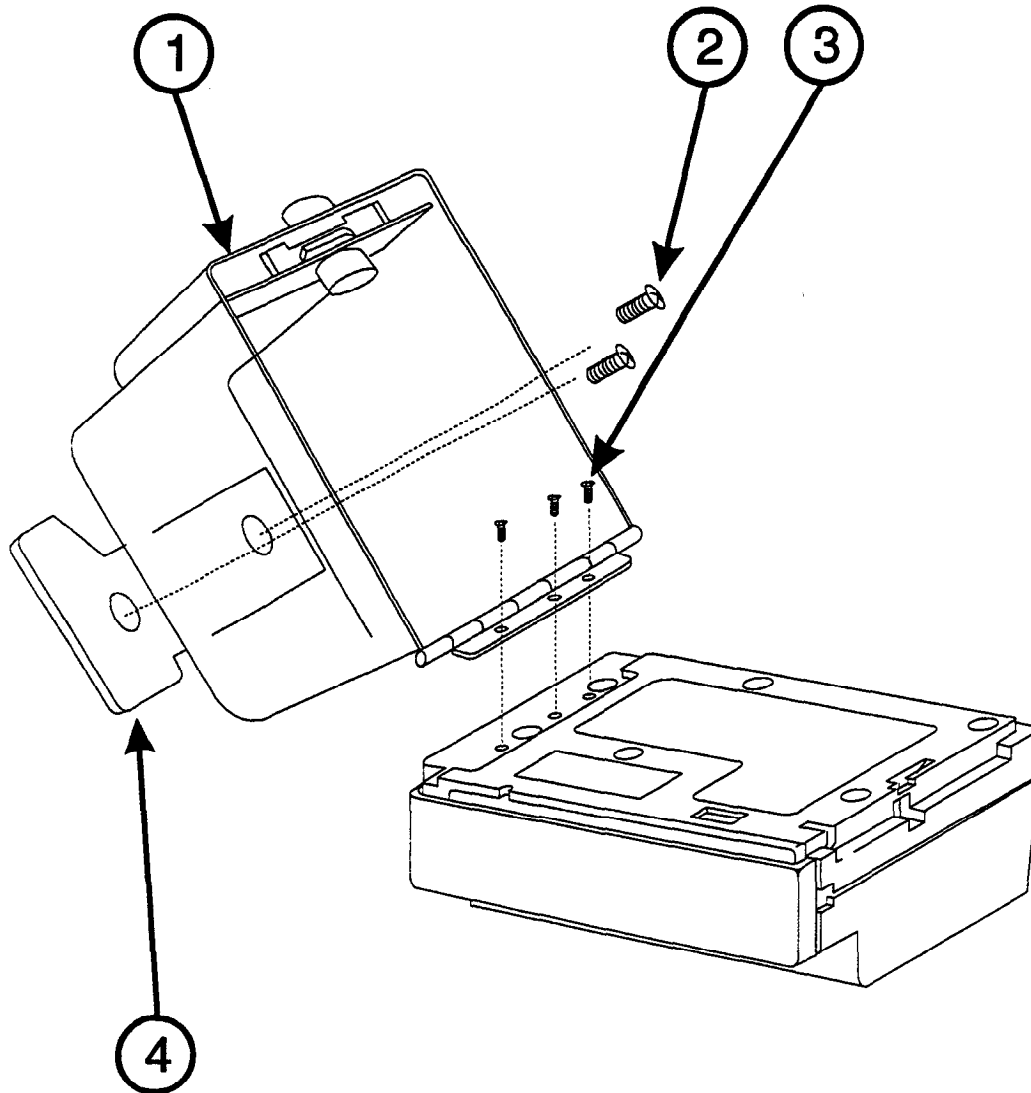


Figure 7-1 Reservoir Assembly Removal

7.2.2 Rear Case Half Assembly

1. Remove the Reservoir Assembly by following the procedure in section 7.2.1.
2. Place the Pump face down on a flat clean surface.
3. Remove the 6 screws (2) and flat washers (3) from the Rear Case Half (1).

CAUTION

Do not pull the Rear Case Half away from the unit very far. The Rear Case Half has a circuit board mounted to it. The circuit board is connected to the remainder of the unit via a semi-rigid PC board (4). Extreme care must be taken to prevent any damage to the semi-rigid PC board. To remove the circuit board from the rear case refer to MPU Circuit Board Removal (7.2.4) later in this chapter.

4. Gently lift the Rear Case Half (1) from the rest of the Pump assembly and lay over on its back.

NOTE

When re-assembling the Rear Case Half, make sure the Mechanism ribbon cable is not overlapping the Battery Wall.

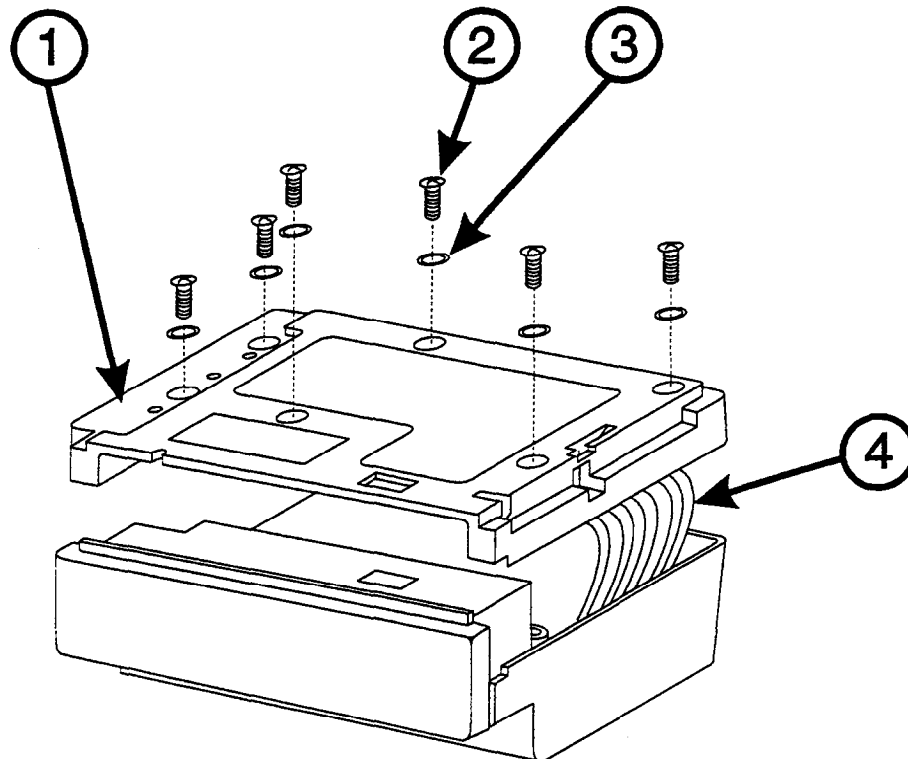


Figure 7-2 Rear Case Half Assembly

7.2.3 Mechanism Assembly and Battery Compartment Removal

1. Remove the Reservoir Assembly by following the procedure in section 7.2.1. Remove the Rear Case Assembly by following the procedure in section 7.2.2.
2. The Battery Door (6) is free to be removed when the Rear Case is removed.
3. Disconnect the ten pin Mechanism Assembly connector J6 (2) from the unit circuit board (7). Lift the Mechanism Assembly (1) out of the Front Case Assembly.
4. To remove the Battery Wall (5), remove the screw (3), lock washer (4), and lift the wall out of the unit.

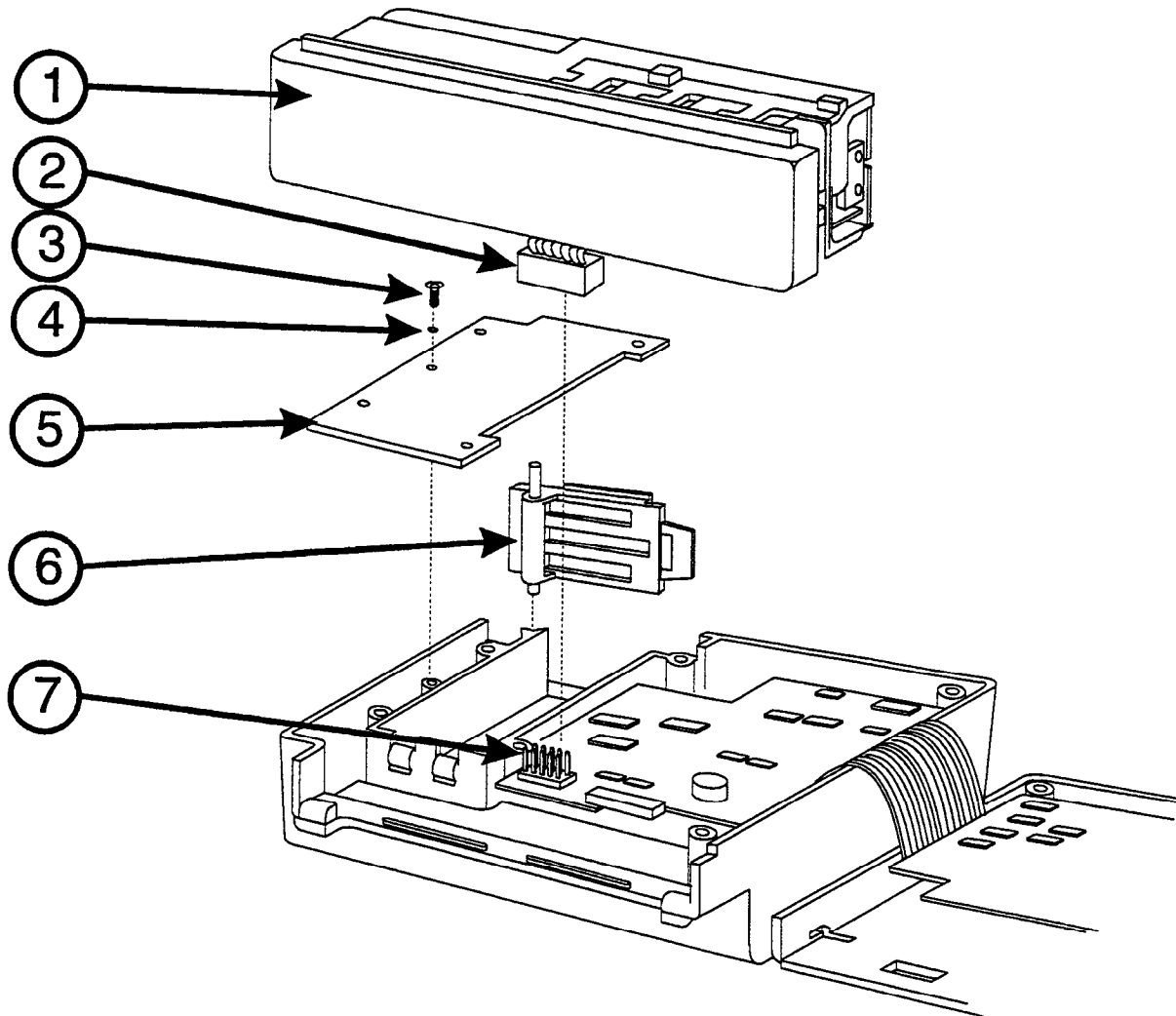


Figure 7-3 Mechanism Assembly and Battery Compartment Removal

7.2.4 MPU Circuit Board Assembly

1. Remove the Reservoir Assembly by following the procedure in section 7.2.1. Remove the Rear Case Assembly by following the procedure in section 7.2.2. Remove the Mechanism Assembly by following the procedures in section 7.2.3.
2. Remove the three screws (6) and lock washers (8) that hold the Primary MPU Circuit Board (7) to the Rear Case Assembly (11).
3. Disconnect the Reed Switch cable (10) from J1 (9) on the under side of the Primary MPU Circuit Board (7). Remove the ESD Shield (12). The Rear Case (11) can now be removed.

CAUTION

USE EXTREME CARE WHEN DISCONNECTING AND HANDLING THE MPU CIRCUIT BOARD.

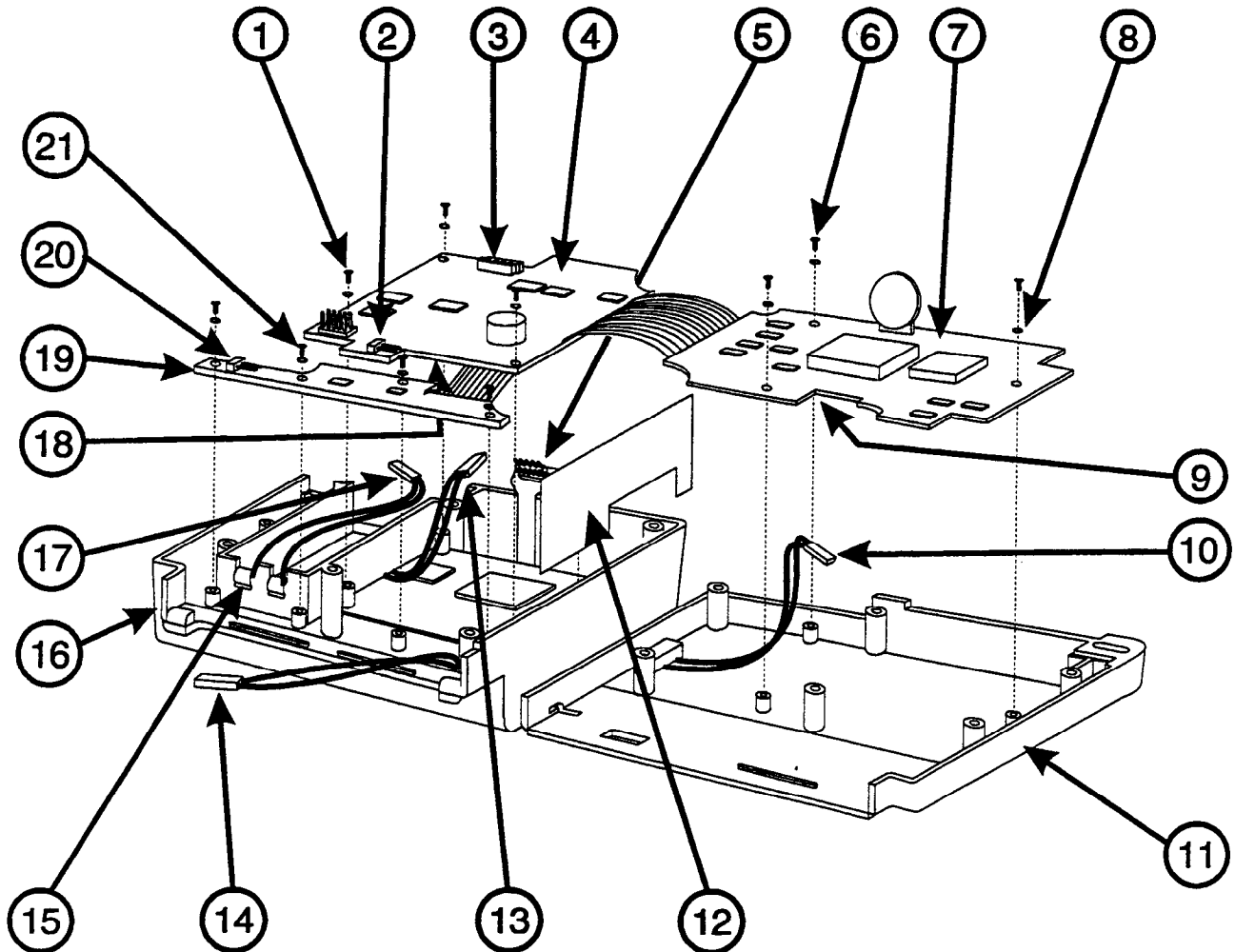


Figure 7-4 MPU Circuit Board Assembly

NOTE

If Backup Battery replacement is required, proceed to section 7.2.5.

4. Disconnect the ten pin keypad cable (5) from J8/J9 (3) on the Secondary MPU Circuit Board (4). Disconnect the two pin battery cable (17) from J10 (2) on the Secondary MPU Circuit Board (4) and remove the Battery Contact Assembly (15).
5. Remove the three screws (1) and lock washers (8) that hold the Secondary MPU Circuit Board (4) to the Front Case Assembly (16). Gently lift the Secondary MPU Circuit Board (4) out of the Front Case Assembly (16).

NOTE

There is a 14 pin connection between the Secondary MPU Circuit Board (4) and the LCD Circuit Board at J7. When reinstalling, ensure that these pins line up correctly.

6. Disconnect the two pin cable (13) coming from the LCD Module from J2 (18) on the under side of the Secondary MPU Circuit Board (4).
7. Disconnect the two pin AC connector (14) from J4 (20) of the Connector Circuit Board (19).
8. Remove the four screws (21) and lock washers (8) that hold the Connector Circuit Board (19) to the Front Case Assembly (16). The MPU Circuit Assembly can now be lifted from the case.

7.2.5 3V Backup Battery Replacement

1. Perform steps 1, 2, and 3 of section 7.2.4.
2. Remove the 2-pin jumper connector (1) J11, next to the Backup Battery (2).

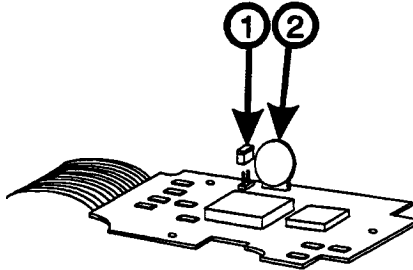


Figure 7-5 Backup Battery Replacement

3. Carefully flip the Front Case/MPU Board Assembly and desolder the Battery from the board.
4. Solder the replacement Battery to the board.
5. Carefully flip the entire assembly back over.
6. Connect the Reed Switch cable to J1 on the underside of the MPU Board (see step 3 of section 7.2.4). Mount the MPU Board back to the Rear Case (see step 2 of section 7.2.4).
7. Re-assemble the Battery Wall to the Front Case (see step 4 of section 7.2.3).
8. Re-assemble the Mechanism Assembly to the Front Case and MPU Board (see step 3 of section 7.2.3).
9. Re-install the ESD Shield into position (see step 3 of section 7.2.4).
10. Re-insert the Battery door into position (see step 2 of section 7.2.3).
11. Snap the Rear Case Assembly onto the Front Case Assembly and temporarily hold the Case Halves in place with one of the six rear case mounting screws (see step 3 of section 7.2.2).
12. **The Backup Battery must be initialized as follows:**

Insert a 9V Battery into the Pump and press the ON/OFF key to power up the Pump.
13. After the self-test is complete, remove the rear case screw, open the rear case and install the 2-pin jumper connector (1) onto J11 on the board.

7.2.6 LCD Circuit Board Assembly

1. Remove the Reservoir Assembly by following the procedure in section 7.2.1.
Remove the Rear Case Assembly by following the procedure in section 7.2.2.
Remove the Mechanism Assembly by following the procedure in section 7.2.3.
Remove the MPU Circuit Board Assembly by following the procedure in section 7.2.4.
2. Remove the screw (2), lock washer (3), and three standoffs (1) that secure the LCD Circuit Board (4) to the Front Case Assembly.
3. Lift the LCD Circuit Board Assembly clear of the Front Case Assembly.

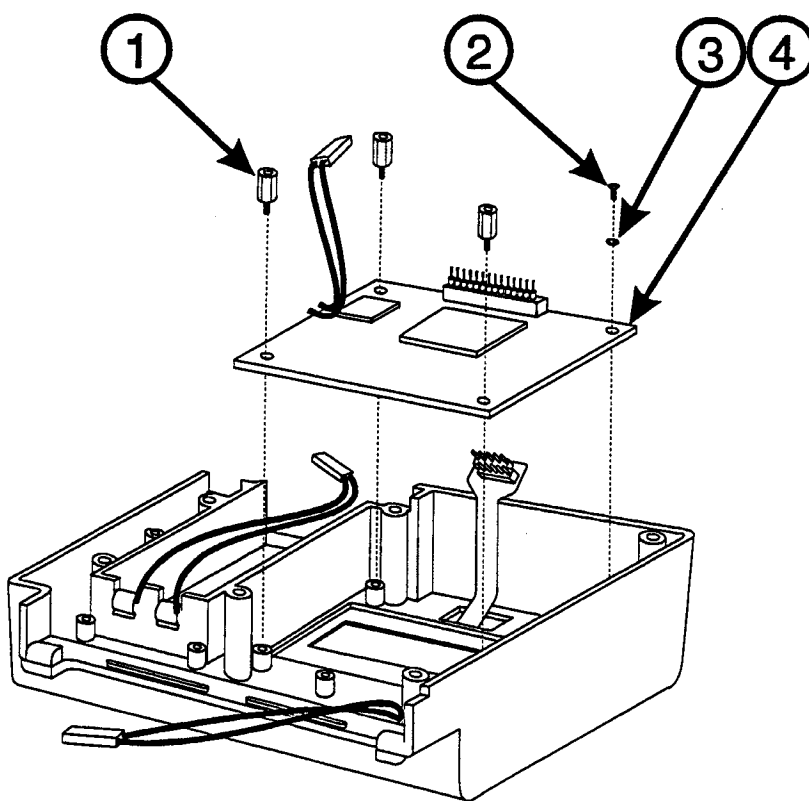


Figure 7-6 LCD Circuit Board Assembly

7.2.7 Keypad

1. Remove the Reservoir Assembly by following the procedure in section 7.2.1.
Remove the Rear Case Assembly by following the procedure in section 7.2.2.
Remove the Mechanism Assembly by following the procedures in section 7.2.3.
Remove the MPU Circuit Board Assembly by following the procedures in section 7.2.4.
Remove the LCD Circuit Board Assembly by following the procedures in section 7.2.6.

NOTE

A keypad cannot be reused after it has been removed.

2. Turn the Front Case (3) over with the Keypad (1) facing up. Lift the corner of the Keypad (1) and carefully peel the Keypad (1) from the Front Case (3).
3. Carefully pry off the Keypad Cover (2) from the Front Case (3).
4. Clean off the adhesive from the Front Case (3).

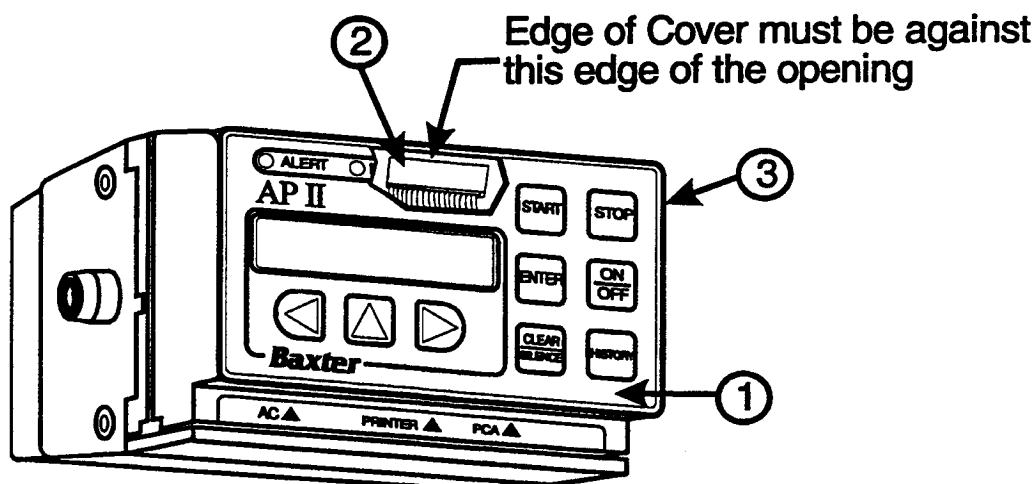


Figure 7-7 Keypad Assembly

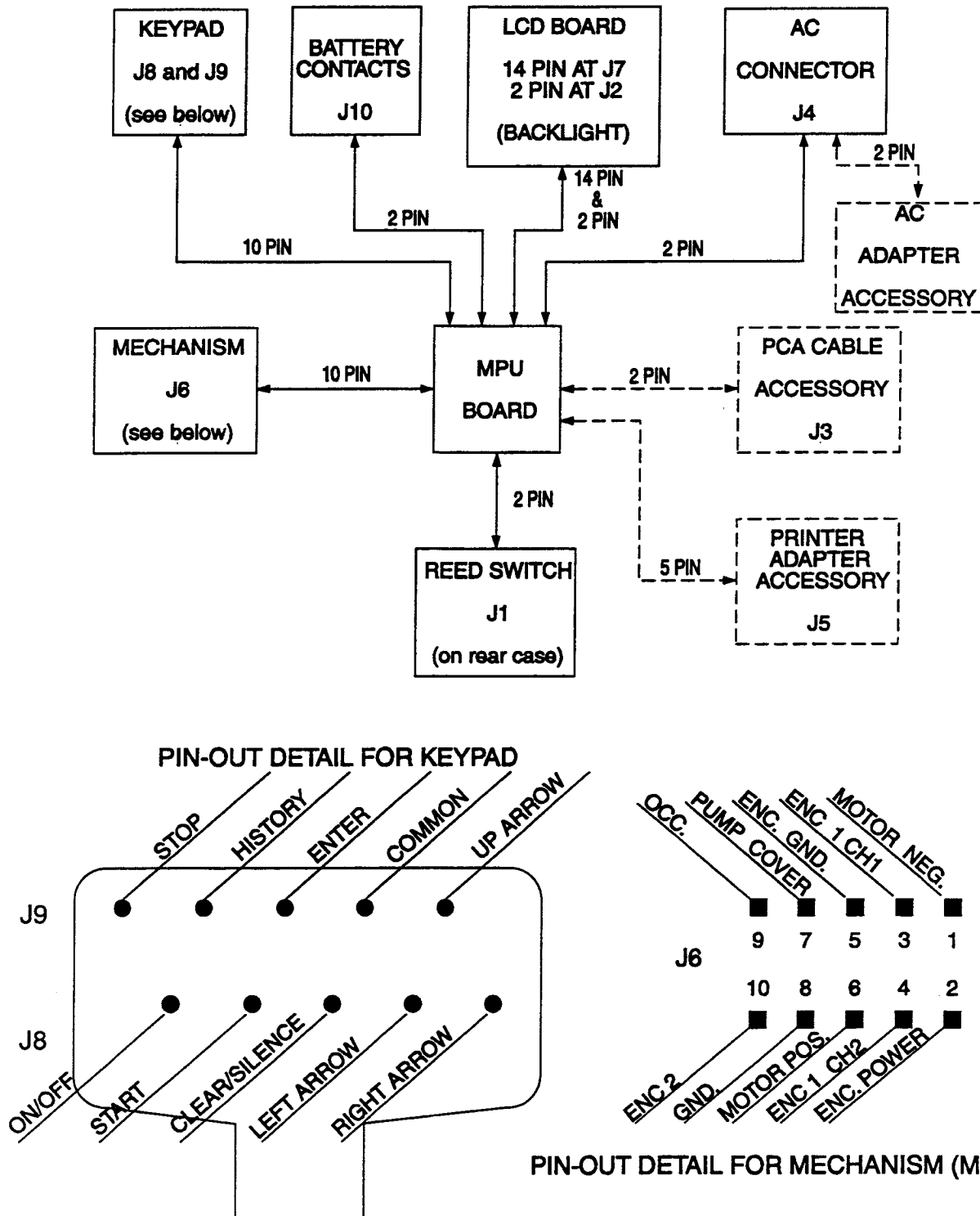
Re-Assembly Notes

1. Remember to insert the Keypad tail through the Front Case opening before adhering the Keypad Cover (2) in place.
2. Use PermaBond 792 adhesive to adhere the Keypad Cover (2) to the Front Case (3). Allow the adhesive to set for a minimum of one minute.
3. Do not allow the Keypad adhesive to contact the Front Case (3) until the Keypad (1) is in proper position.

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A.1 GENERAL

This appendix contains the schematic diagram necessary for the technician to work on the AP II Pump.

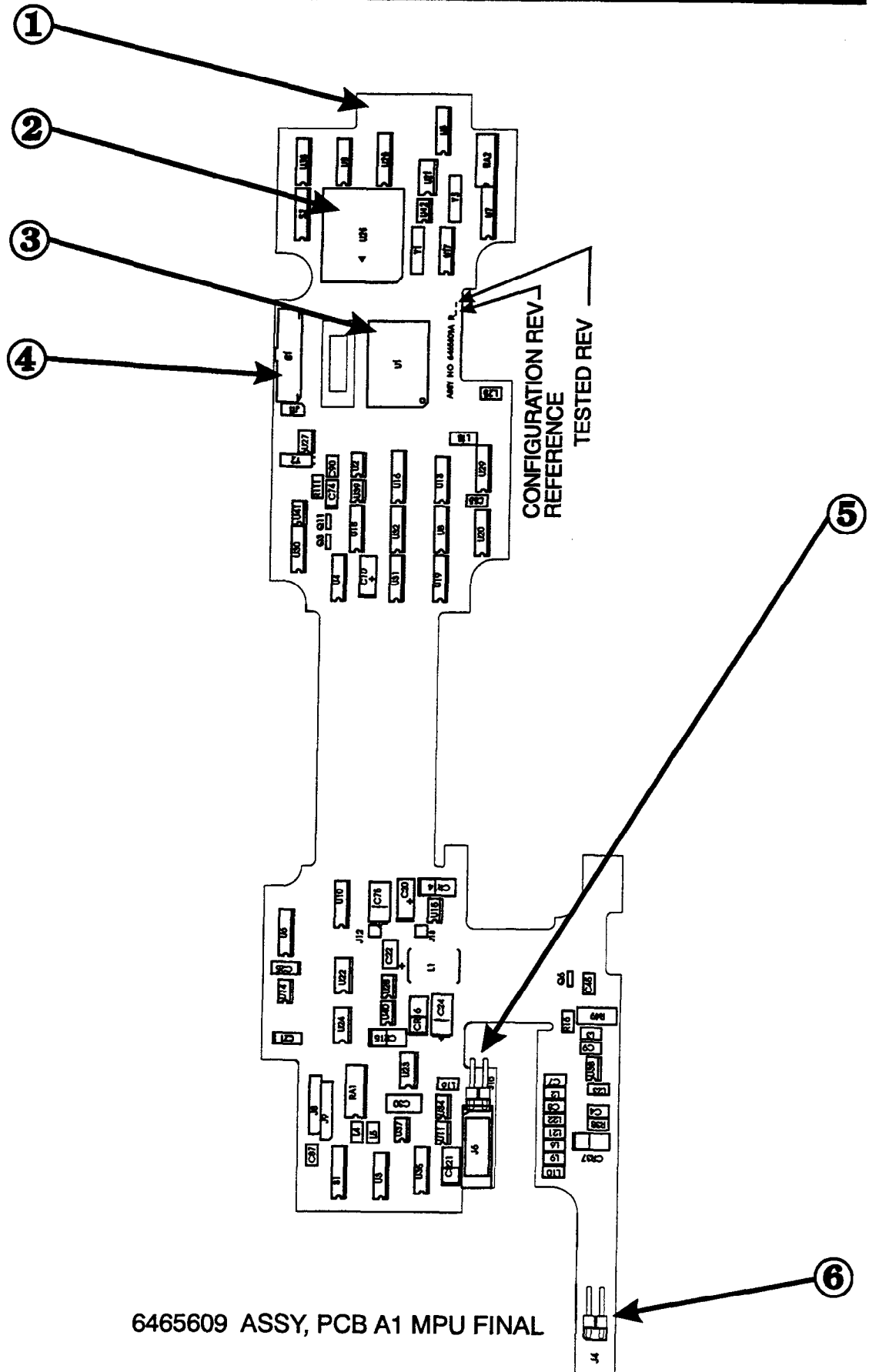


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B.1 GENERAL

This appendix contains the circuit board assembly drawing for the AP II Pump. A table of contents for this section is shown below:

Drawing Number	Description
6465609	ASSY, PCB A1 MPU FINAL



C.1 GENERAL

This appendix contains a part listing of the components of the AP II Pump. There are three part list types contained in this appendix, by major component, alphabetical, and numerical. The numerical and alphabetical lists are cross referenced to the assembly specific parts list by figure and index number.

C.2 ASSEMBLY PART LISTINGS

This section is broken down as follows:

- A) Reservoir Assembly
- B) Rear Case Half Assembly
- C) Mechanism Assembly and Battery Compartment
- D) MPU Board Assembly and ESD Shield
- E) LCD Circuit Board Assembly and Front Case Half Parts

C.2.1 Reservoir Assembly

Table C-A Reservoir Assembly Parts

Figure ID Number	Description	Baxter Part Number	Quantity per Assembly
A1	250 mL Extended Bag Holder Assembly or 250 mL Bag Holder Assembly or 100 mL Bag Holder Assembly (All of the above p/n's include items A2 and A4)	6465635 6465650 6465640	1 1 1
A2	#6 x 5/16" Self-Tap Screws	5101180	2
A3	2-56 x 1/4" Pan Head Screws	5101101	3
A4	Mounting Plate	6465644	1

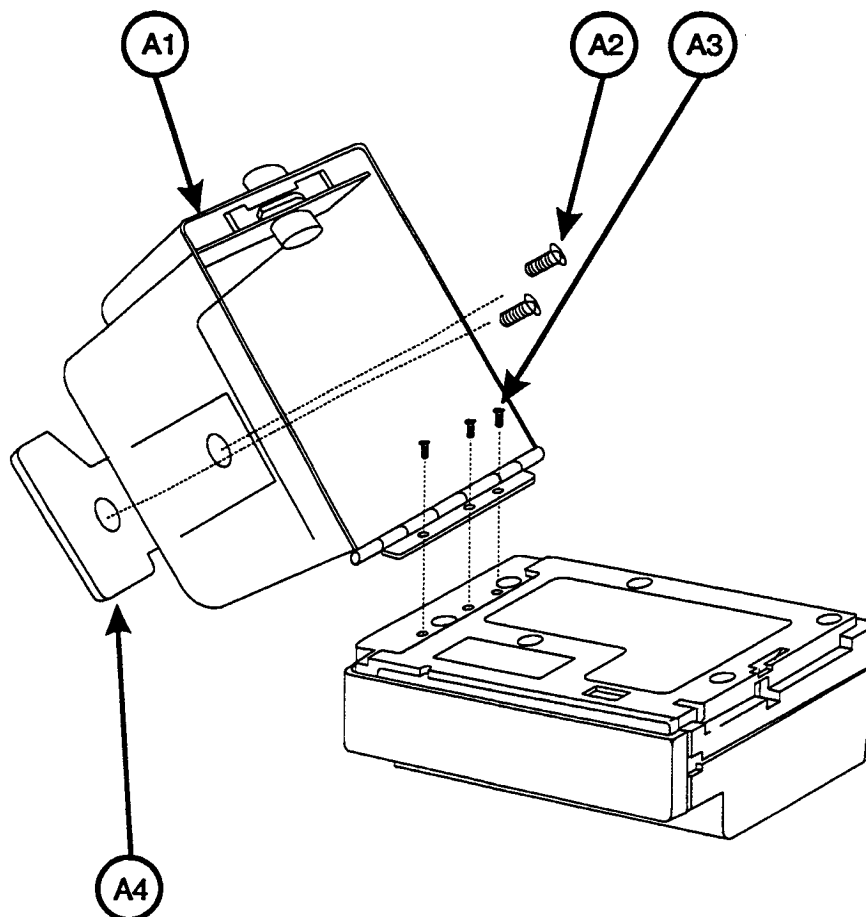


Figure A Reservoir Assembly Parts

C.2.2 Rear Case Half

Table C-B Rear Case Half Parts

Figure ID Number	Description	Baxter Part Number	Quantity per Assembly
B1	Rear Case Assembly (Includes item B4)	6465578RP	1
B2	2-56 x 3/8" Pan Head Screws	5101103	6
B3	#2 Flat Washer	5143011	6
B4	Rear Label	6465561	1

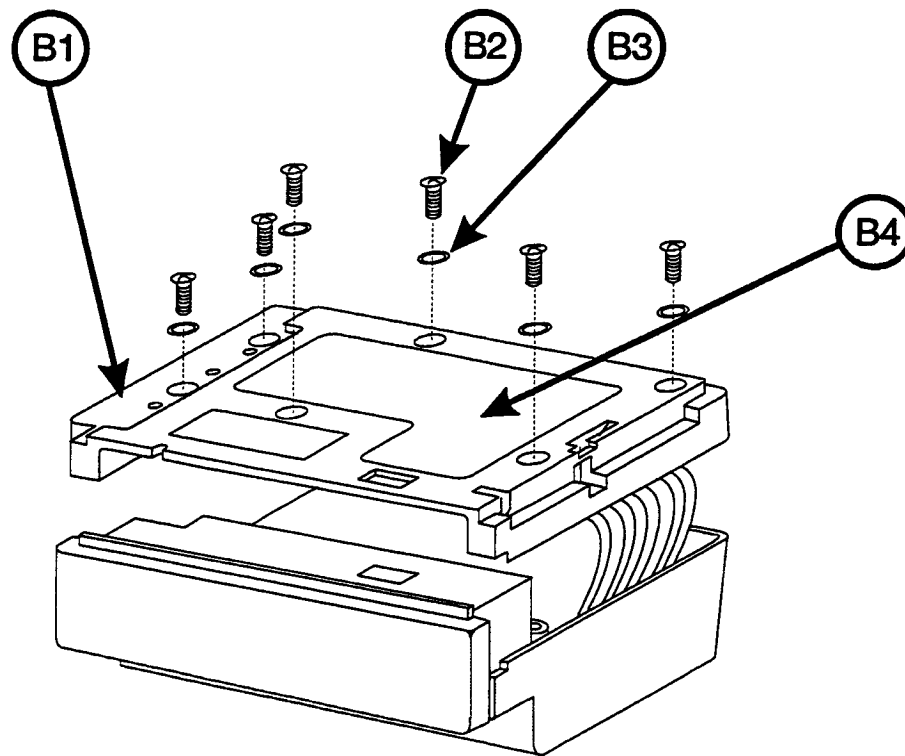


Figure B Rear Case Half Parts

C.2.3 Mechanism Assembly and Battery Compartment Parts

Table C-C Mechanism Assembly and Battery Compartment Parts

Figure ID Number	Description	Baxter Part Number	Quantity per Assembly
C1	Mechanism Assembly	6465606RP	1
C2	Battery Wall Assembly (Includes item C3)	6465645RP	1
C3	Battery Polarity Label	6465560	1
C4	2-56 x 1/4" Pan Head Screw	5101101	1
C5	#2 Spring Lockwasher	5110049	1
C6	Battery Door	6465592	1

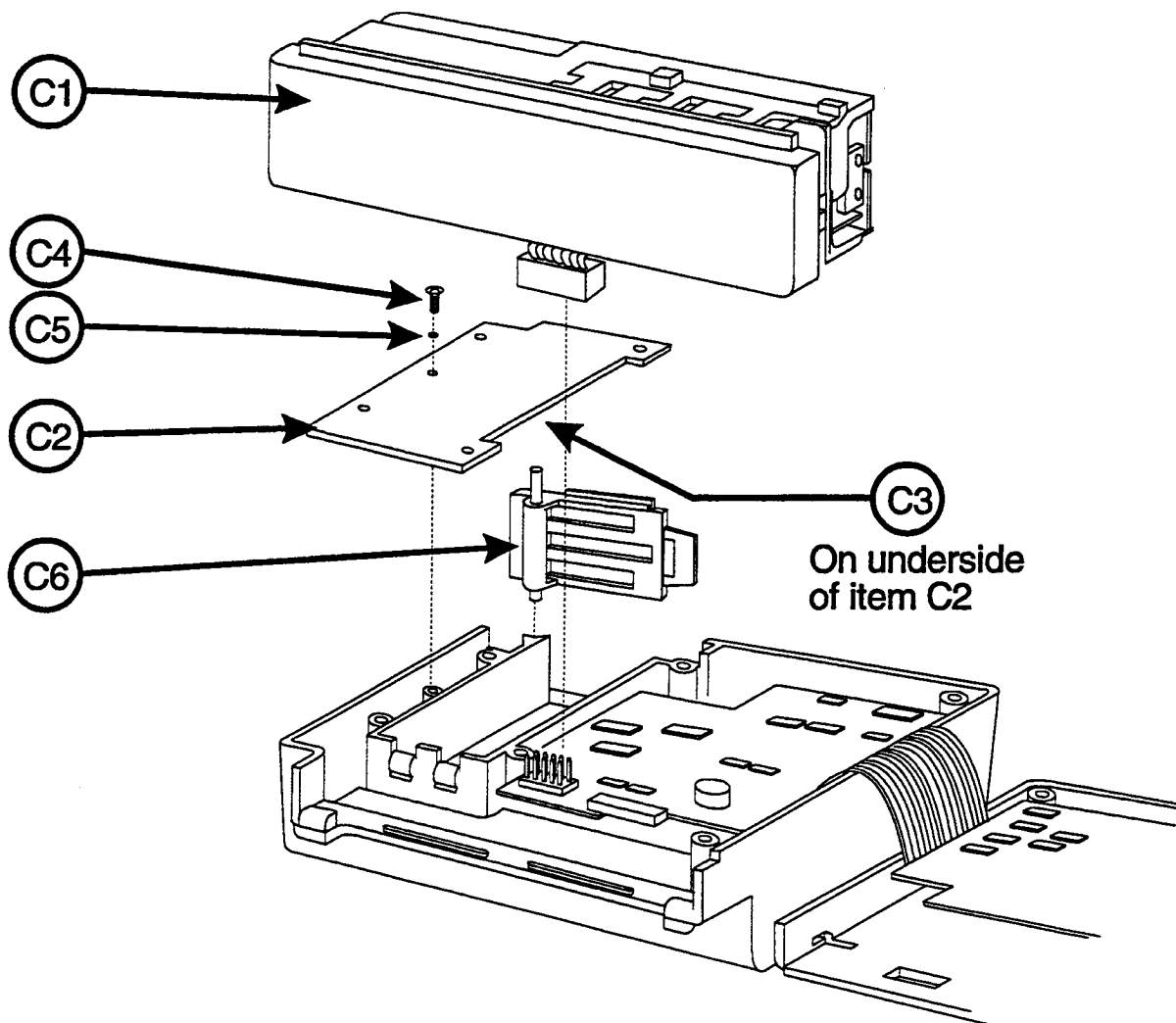


Figure C Mechanism Assembly and Battery Compartment Parts

C.2.4 MPU Board Assembly Parts and ESD Shield

Table C-D MPU Board Assembly Parts and ESD Shield

Figure ID Number	Description	Baxter Part Number	Quantity per Assembly
D1	MPU Board Assembly (Includes items D2 and D3)	6465609RP	1
D2	3V Backup Battery	6465634	1
D3	2-Pin Jumper Connector	010135126	1
D4	2-56 x 1/4" Pan Head Screws	5101101	10
D5	#2 Spring Lockwashers	5110049	10
D6	ESD Shield	6465649	1

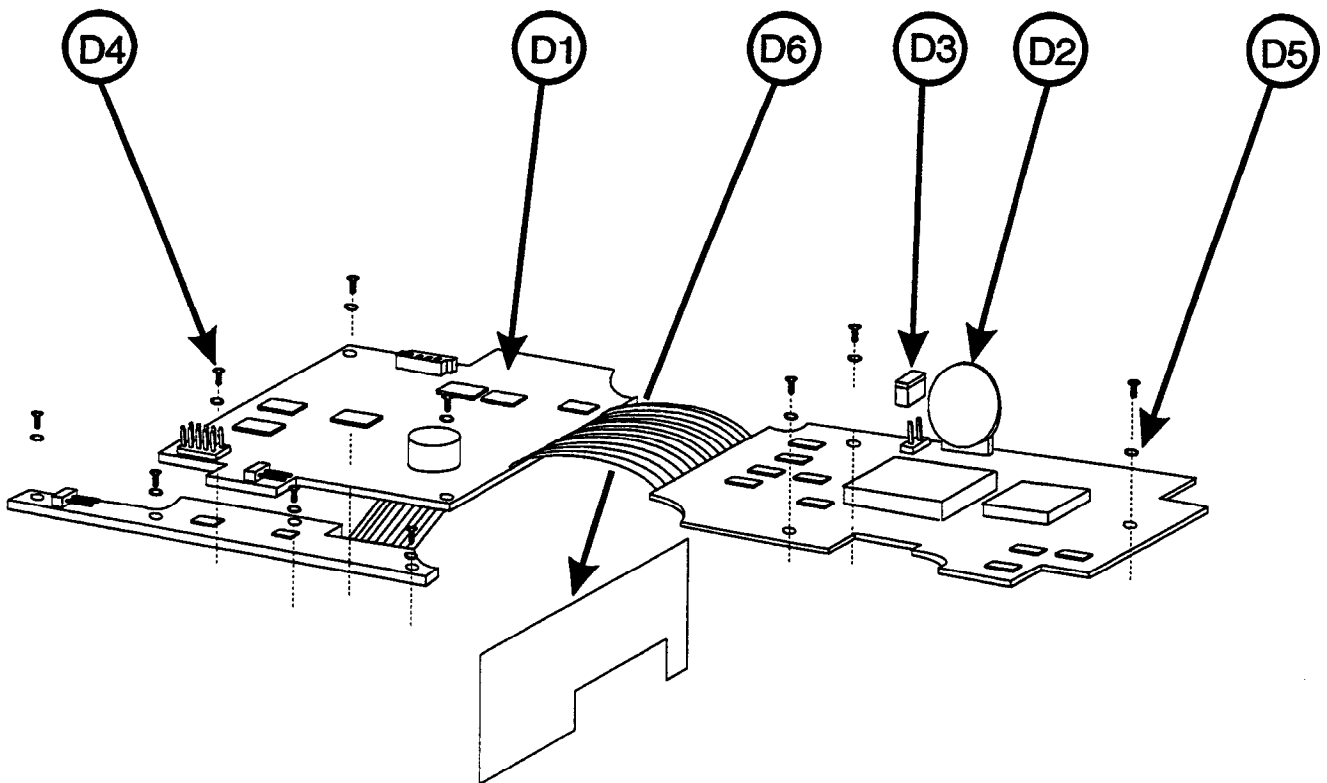


Figure D MPU Board Assembly Parts and ESD Shield

C.2.5 LCD Circuit Board Assembly and Front Case Half Parts

Table C-E LCD Circuit Board Assembly and Front Case Half Parts

Figure ID Number	Description	Baxter Part Number	Quantity per Assembly
E1	LCD Circuit Board Assembly	6465624RP	1
E2	2-56 Standoffs	5125114	3
E3	2-56 x 1/4" Pan Head Screws	5101101	1
E4	#2 Spring Lockwasher	5110049	1
E5	Front Case W/O Board Assembly (Includes items E7 and E8)	6465590RP	1
E6	Battery Contact Assembly	6465570RP	1
E7	Keypad Assembly (Includes item E8)	6465540RP	1
E8	Keypad Cover	6465614	1

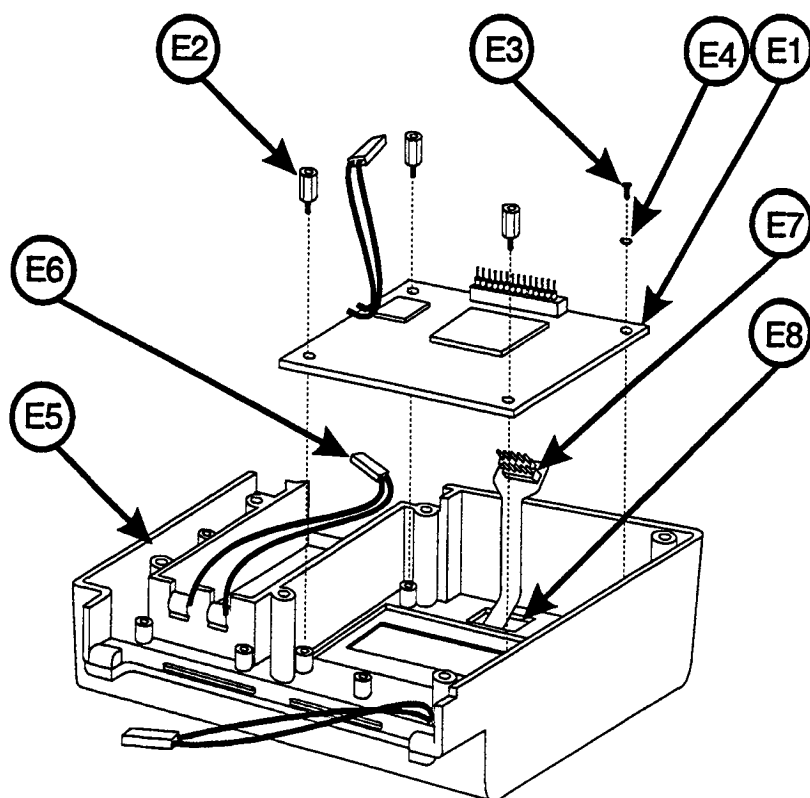


Figure E LCD Circuit Board Assembly and Front Case Half Parts

C.3 ALPHABETICAL PARTS LIST

Description	Baxter Part Number	Figure Number	Index Number	Unit Qty
#2 Flat Washer	5143011	B	B3	6
#2 Spring Lockwasher	5110049	C	C5	1
#2 Spring Lockwasher	5110049	E	E4	1
#2 Spring Lockwashers	5110049	D	D5	10
#6 x 5/16" Self-Tap Screws	5101180	A	A2	2
100 mL Bag Holder Assembly	6465640	A	A1	1
2-56 Standoffs	5125114	E	E2	3
2-56 x 1/4" Pan Head Screws	5101101	A	A3	3
2-56 x 1/4" Pan Head Screw	5101101	C	C4	1
2-56 x 1/4" Pan Head Screws	5101101	D	D4	10
2-56 x 1/4" Pan Head Screw	5101101	E	E3	1
2-56 x 3/8" Pan Head Screws	5101103	B	B2	6
2-Pin Jumper Connector	010135126	D	D3	1
250 mL Bag Holder Assembly	6465650	A	A1	1
250 mL Extended Bag Holder Assembly	6465635	A	A1	1
3V Backup Battery	6465634	D	D2	1
Battery Contact Assembly	6465570RP	E	E6	1
Battery Door	6465592	C	C6	1
Battery Polarity Label	6465560	C	C3	1
Battery Wall Assembly	6465645RP	C	C2	1
ESD Shield	6465649	D	D6	1
Front Case W/O Board Assembly	6465590RP	E	E5	1
Keypad Assembly	6465540RP	E	E7	1
Keypad Cover	6465614	E	E8	1
LCD Circuit Board Assembly	6465624RP	E	E1	1
Mechanism Assembly	6465606RP	C	C1	1
Mounting Plate	6465644	A	A4	1
MPU Board Assembly	6465609RP	D	D1	1
Rear Case Assembly	6465578RP	B	B1	1
Rear Label	6465561	B	B4	1

C.4 NUMERICAL PARTS LIST

Baxter Part Number	Description	Figure Number	Index Number	Unit Qty
010135126	2-Pin Jumper Connector	D	D3	1
5101101	2-56 x 1/4" Pan Head Screws	A	A3	3
5101101	2-56 x 1/4" Pan Head Screw	C	C4	1
5101101	2-56 x 1/4" Pan Head Screws	D	D4	10
5101101	2-56 x 1/4" Pan Head Screw	E	E3	1
5101103	2-56 x 3/8" Pan Head Screws	B	B2	6
5101180	#6 x 5/16" Self-Tap Screws	A	A2	2
5110049	#2 Spring Lockwasher	C	C5	1
5110049	#2 Spring Lockwasher	E	E4	1
5110049	#2 Spring Lockwashers	D	D5	10
5125114	2-56 Standoffs	E	E2	3
5143011	#2 Flat Washer	B	B3	6
6465540RP	Keypad Assembly	E	E7	1
6465560	Battery Polarity Label	C	C3	1
6465561	Rear Label	B	B4	1
6465570RP	Battery Contact Assembly	E	E6	1
6465578RP	Rear Case Assembly	B	B1	1
6465590RP	Front Case W/O Board Assembly	E	E5	1
6465592	Battery Door	C	C6	1
6465606RP	Mechanism Assembly	C	C1	1
6465609RP	MPU Board Assembly	D	D1	1
6465614	Keypad Cover	E	E8	1
6465624RP	LCD Circuit Board Assembly	E	E1	1
6465634	3V Backup Battery	D	D2	1
6465635	250 mL Extended Bag Holder Assembly	A	A1	1
6465640	100 mL Bag Holder Assembly	A	A1	1
6465644	Mounting Plate	A	A4	1
6465645RP	Battery Wall Assembly	C	C2	1
6465649	ESD Shield	D	D6	1
6465650	250 mL Bag Holder Assembly	A	A1	1

D.1 GENERAL

This appendix describes major updates to the AP II Pump. The updates are listed by serial number and/or hardware and software revision number of when the change occurred. In many instances a different part number is assigned for compatibility reasons. To ensure proper fit and operation of parts, make sure that you check all updates that may apply to a particular serial number.

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Revision	Date	General Description of Changes
0	5/95	Release

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